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Helminths of the Roseate Spoonbill, *Ajaia ajaja*, in Southern Florida

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ABSTRACT: One hundred and thirty-six nestling, juvenile, and adult roseate spoonbills, *Ajaia ajaja*, were collected from southern Florida and examined for parasitic helminths. One hundred and twenty-one (89%) of the birds were infected with at least 1 of 28 species of helminths including 15 trematodes, 7 nematodes, 3 cestodes, and 3 acanthocephalans. Twenty species are new host records, while 7 are reported from Florida for the first time. Of the parasites studied, the prevalence of *Echinochasmus dietzevi* and the intensity of infection of *Contracaecum multipapillatum* showed statistically significant differences between sexes and amount of body fat, respectively. Generally, the prevalence and intensity of helminths were significantly higher in older roseate spoonbills and in birds from eastern Florida Bay colonies. In addition, the prevalence and/or intensity of infection of the trematodes *Phagicola longa*, *Microphallus turgidus*, and *Ascocotyle mcintoshi* and of the nematode *Contracaecum multipapillatum* varied significantly between years. These differences were attributed to hydropattern changes on the roseate spoonbill's feeding grounds through the years.

KEY WORDS: roseate spoonbill, *Ajaia ajaja*, Florida, helminths, prevalence, intensity.

The roseate spoonbill, *Ajaia ajaja* (Allen, 1942), ranges from southern Florida to central Chile and Argentina (American Ornithologists' Union, 1983). This species was very abundant in Florida Bay, but the population was drastically reduced by human harvesting and plume hunting (Powell et al., 1989). Even though roseate spoonbills in Florida have experienced a notable recovery through the years, they are considered specially susceptible to habitat disturbances in southern Florida due to their small population and high trophic position in relatively complex food webs (Powell et al., 1989).

The present study constitutes the first systematic survey of the parasites of the roseate spoonbill. Previously, a small number of spoonbills from South, Central, and North America have been examined and a total of 18 species of helminths have been found (Brandes, 1888; Cram, 1927; Freitas and Almeida, 1935; Caballero, 1939; Petrochenko, 1958; Dubois and Macko, 1972; Huey and Dronen, 1981; Dronen, 1985).

The objectives of this study were to survey the helminthofauna of the roseate spoonbill in southern Florida and to relate statistically the prevalence and intensity of infection of these helminths to host age, sex, body fat, locality, and year.

Materials and Methods

One hundred thirty-three roseate spoonbills, found dead in 12 colonies on mangrove islands in Florida Bay, were collected during the breeding seasons (December–March) of 1986–1987 through 1991–1992. Severely autolyzed birds were not included in the study. Colonies consisted of those in eastern Florida Bay (Tern Key, Porjoe Key, South Park Key, North Park Key, Pigeon Key, Central Jimmy Key, Cowpens Key, Crane Key, East Buchanan Key, Grassy Key, Key Largo), and 1 in western Florida Bay (Sandy Key) (Fig. 1). Nestlings were assigned to 1 of 2 categories based on bill length measured from the base of the bill to the tip of the maxilla and into juvenile or adult categories based on plumage (Spalding and Forrester, 1993). The nestling categories included small nestlings, less than 60% of adult bill length, and large nestlings, greater than 60% of adult bill length. The sample included a total of 19 small nestling males, 48 small nestling females, 11 large nestling males, 11 large nestling females, 39 nestlings of unknown sex, 1 juvenile female, 2 adult males, 1 adult female, and 1 bird of unknown age. In addition, the carcasses of 1 adult male found at Lake Okeechobee in July 1971, of 1 juvenile female from Tamiami Trail collected in February 1990, and 1 juvenile male from Key West collected in July 1991 were included in the study (Fig. 1). Body fat reserves were assessed as: abundant, moderate, slight, or none.

Complete necropsy examinations were performed on fresh or frozen carcasses and techniques for recovering, fixing, and staining helminths were similar to those described by Kinsella and Forrester (1972). The terms

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prevalence, mean intensity, and abundance follow the definitions given by Margolis et al. (1982).

Chi-square and Wilcoxon tests were used to evaluate differences in prevalence and mean intensities of infection respectively, between years, colonies, ages, sexes, and amount of body fat on the birds (SAS Institute Inc., 1988). Prevalence and mean intensities for birds collected during 1986–1987 and 1990–1991, and of juveniles and adults were excluded from the statistical analysis by year and by age, respectively, because of the small sample sizes. Helminth fauna comparison was performed using the index of similarity from Holmes and Podesta (1968).

Voucher specimens have been deposited in the U.S. National Parasite Collection, Beltsville, Maryland (USNM 82336 and 83028–83053).

Results and Discussion

Twenty-eight species of helminths with a mean of 4.3 (range, 1–13) per host were identified from 121 of 136 (89%) roseate spoonbills. Of the birds that were not infected, 13 were small nestlings, and 2 were large nestlings. Helminths identified comprised 15 trematodes, 7 nematodes, 3 cestodes, and 3 acanthocephalans. The prevalence, number of helminths per infected bird, abundance, and location in the host of each of the species are presented in Table 1. Twenty species are new host records, while 7 are recorded from Florida for the first time. In Table 2 the prevalence and mean intensity of helminths collected from nestling, juvenile, and adult roseate spoonbills are listed.

Trematoda

Eighty-three birds (61%) harbored at least 1 species of digenetic trematode. The family Heterophyidae was represented by four species: *Ascocotyle chandleri* (Lumsden 1963), *Ascocotyle mcintoshi* (Price, 1936), *Phagicola longa* (Ransom, 1920), and *Pygidiopsis pindoramensis* (Travassos, 1929). *Ascocotyle chandleri,* the most frequently occurring trematode in this study, was usually found buried inside small nodules in the small intestine, alone or in groups of up to 3 individuals. Roseate spoonbills are the only known definitive hosts for this species (Dronen, 1985). *Phagicola longa* occurred in high intensities (on 1 occasion, more than 47,000 specimens were found in a bird). *Ascocotyle mcintoshi* and *P. longa* have been reported in Florida from ciconiiforms and pelecaniforms (Price, 1936; Hutton and Sogandares-Bernal, 1960; Hutton, 1964; Courtney and Forrester, 1974; Bush and Forrester, 1976; Threlfall, 1982). *Pygidiopsis pindoramensis* has been described from herons from Brazil and Argentina (Yamaguti, 1971; Ostrowski de Nuñez, 1976). The present study is the first report of this parasite in the United States.

Three species of echinostomes were found: *Echinochasmus dietzevi* (Issaitschikoff, 1927), *Stephanoprora denticulata* (Rudolphi, 1802), and *Microparyphium facetum* (Dietz, 1909). Even though *E. dietzevi* was the second most abundant trematode collected during the study, this is the first report for the parasite in Florida. A single specimen of *M. facetum* was collected from the cloaca of an adult male collected in Lake Okeechobee. *Stephanoprora denticulata* and *M. facetum* have been reported in Florida from herring gulls (*Larus argentatus*) (Hutton and Sogandares-Bernal, 1960; Hutton, 1964), black skimmers (*Rynchops nigra*) (Sogandares-Bernal, 1959; Kinsella, 1972), brown pelicans (*Pelecanus occidentalis*) (Courtney and Forrester, 1974), and white ibises (*Eudocimus albus*) (Bush and Forrester, 1976).

Two species of microphallids were found: *Microphallus turgidus* (Leigh, 1958) and *Levinseniella* sp. Leigh (1958) originally described *M. turgidus* from racoons (*Procyon lotor*) collected in the Everglades, and since then it has been found in clapper rails (*Rallus longirostris*), white ibises, and brown pelicans from Florida (Heard, 1967; Courtney and Forrester, 1974; Bush and Forrester, 1976). Dronen (1985) described this microphallid from roseate spoonbills in Texas as *Carneophallus choanophallus* (=*M. turgidus,* Deblock, 1971). *Levinseniella* sp. was found in a single adult bird from Lake Okeechobee.

Renicola ralli (Byrd and Heard, 1970) was the only member of the family Renicolidae found during this study. This species was first described from the clapper rail-inhabiting marshes and mangrove areas of Florida (Byrd and Heard, 1970). The black skimmer is also a host for this species in Florida (Kinsella, 1972). Members of the genus *Renicola* are found commonly in kidneys of birds. However, in the present study specimens of *R. ralli* were collected not only from kidneys (29%) but also from cloaca (39%), large intestine (14%), and body cavity (13%). The latter 3 locations are possibly accidental resulting from the migration of the worms after the death of the host.

The family Clinostomidae was represented by the species *Clinostomum complanatum* (Rudolphi, 1819). In Florida, this fluke has been collected from the oral cavity of the white ibis and from the trachea and lungs of the double-crested

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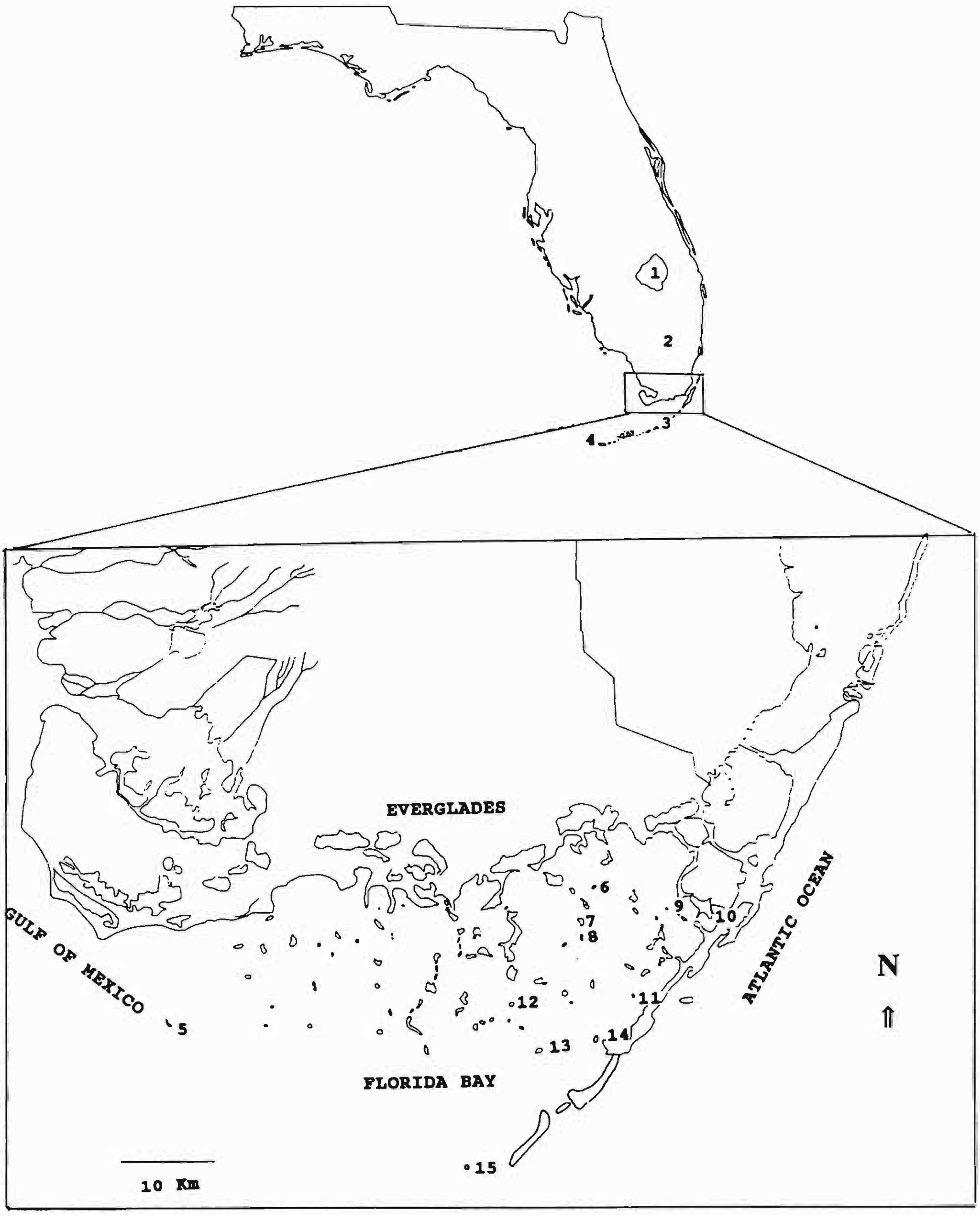

Figure 1. Collection sites of 136 roseate spoonbills in southern Florida, with numbers of birds collected in parentheses. 1. Lake Okeechobee (1); 2. Tamiami Trail (1); 3. Grassy Key (1); 4. Key West (1); 5. Sandy Key (34); 6. Tern Key (48); 7. North Park Key (8); 8. South Park Key (5); 9. Porjoe Key (24); 10. Key Largo (1); 11. Pigeon Key (2); 12. Central Jimmy Key (3); 13. Crane Key (3); 14. Cowpens Key (3); 15. Buchanan Key (1).

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Table 1. Helminths of 136 roseate spoonbills from southern Florida.

Helminth*	Prevalence %	Number of worms per infected bird		Abundance
		Mean	Range	
Trematoda				
Ascocotyle chandleri† (3) (USNM 83028)	45	385	1–3,986	173
Echinochasmus dietzevi†‡ (3) (USNM 83029)	43	518	1–3,140	223
Phagicola longa‡ (3) (USNM 83030)	38	1,942	1–47,449	738
Microphallus turgidus (3, 4) (USNM 83031)	33	112	1–1,386	37
Ascocotyle mcintoshi‡ (3) (USNM 83032)	29	84	1–963	24
Renicola ralli‡ (4, 5, 7, 8) (USNM 83033)	12	22	1–140	3
Clinostomum complanatum‡ (1) (USNM 83034)	11	2	1–3	<1
Stephanoprora denticulata‡ (3) (USNM 83035)	10	54	2–248	5
Posthodiplostomum minimum‡ (3, 4) (USNM 83036)	10	34	1–202	3
Pygidiopsis pindoramensis†‡ (3, 4) (USNM 83037)	7	104	1–782	7
Apharyngostrigea multiovata (3, 4) (USNM 83038)	4	6	1–10	<1
Mesoophorodiplostomum anterovarium† (3) (USNM 83039)	3	46	1–140	1
Dendritobilharzia pulverulenta‡§ (6) (USNM 83040)	<1	1	–	<1
Microparyphium facetum‡§ (5) (USNM 83041)	<1	1	–	<1
Levinseniella sp.‡§ (3, 4) (not deposited)	<1	6	–	4
Nematoda				
Contracaecum multipapillatum‡ (1–3) (USNM 83042)	63	13	1–152	8
Cosmocephalus obvelatus‖ (1, 2) (USNM 83043)	40	8	1–68	3
Capillaria mergi†‡ (2–4) (USNM 83044)	8	5	1–9	<1
Syncuaria diacantha† (2, 4) (USNM 83045)	6	2	1–3	<1
Tetrameres micropenis‡ (2) (USNM 83046)	2	2	–	<1
Eustrongylides sp.¶ (2) (USNM 82336)	<1	1	–	<1
Synhimantus sp.‡# (2) (USNM 83047)	<1	107	–	79
Cestoda				
Cyclustera capito† (3) (USNM 83048)	43	39	1–240	17
Parvitaenia ibisae‡ (3) (USNM 83049)	17	26	1–307	4
Microsomacanthus sp.‡ (3) (USNM 83050)	<1	25	–	18
Acanthocephala				
Southwellina hispida‡ (3) (USNM 83051)	24	11	1–135	3

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Table 1. Continued.

Helminth*	Prevalence %	Number of worms per infected bird: Mean	Range	Abundance
Arhythmorhynchus sp.‡ (3) (USNM 83052)	<1	1	—	<1
Leptorhynchoides sp.‡ (2) (USNM 83053)	<1	1	—	<1

* Numbers in parentheses indicate most frequent location in host: (1) oral cavity/esophagus, (2) proventriculus/ventriculus, (3) small intestine, (4) large intestine, (5) cloaca, (6) heart, (7) kidneys, and (8) body cavity.

† New record for Florida.

‡ New host record.

§ Found in an adult male, Lake Okeechobee, 1971.

‖ A complex of adults and larvae.

¶ Immature specimen probably of *Eustrongylides ignotus*.

Probably represents an undescribed species.

cormorant, *Phalacrocorax auritus* (Bush and Forrester, 1976; Threfall, 1982).

Three species of strigeids were found: *Posthodiplostomum minimum* (MacCallum, 1921), *Apharyngostrigea multiovata* (Perez Vigueras, 1944), and *Mesoophorodiplostomum anterovarium* (Dronen, 1985). *Posthodiplostomum minimum* has been reported from the small intestine of white ibises in Florida (Bush and Forrester, 1976). Dubois and Macko (1972) reported *A. multiovata* from roseate spoonbills from Cuba, and Conti et al. (1986) found this species in reddish egrets, *Egretta rufescens,* collected at Tern Key, Florida Bay. Specimens from roseate spoonbills in Florida were found in very low prevalence and were always immature or nongravid, suggesting that this bird is probably not the normal definitive host. *Mesoophorodiplostomum anterovarium* was described originally by Dronen (1985) from specimens obtained from roseate spoonbills in Texas.

A single female of the schistosome *Dendritobilharzia pulverulenta* (Braun, 1901) was found in the heart of an adult male collected in Lake Okeechobee. The low prevalence and intensity of infection observed during this study is not surprising since this fluke has been described mainly from anseriforms (Vande Vusse, 1979). However, the actual prevalence of this trematode may be higher because blood vessels and hearts were not commonly examined.

Nematoda

A total of 107 birds (79%) was infected with 1 or more species of nematode belonging to the orders Ascarididea, Spiruridea, Trichuridea, and Dioctophymidea.

Contracaecum multipapillatum (Drasche, 1882; family Heterocheilidae) was the most common nematode encountered during this study. Barus (1966) reported larvae of *Contracaecum* sp. from roseate spoonbills from Cuba. In Florida, this nematode has been reported from the water turkey (*Anhinga anhinga*) (Huizinga, 1971), the brown pelican (Courtney and Forrester, 1974), the double-crested cormorant (*P. auritus*) (Threlfall, 1982), and the reddish egret (Conti et al., 1986).

The family Acuariidae was represented by *Cosmocephalus obvelatus* (Creplin, 1825), *Syncuaria diacantha* (Petter, 1961), and *Synhimantus* sp. *Cosmocephalus obvelatus* has been reported from roseate spoonbills from Cuba and Texas (Barus, 1966; Huey and Dronen, 1981) and from black skimmers and brown pelicans from Florida (Kinsella, 1972; Courtney and Forrester, 1974). *Syncuaria diacantha* was described originally by Petter (1961) from a roseate spoonbill held in captivity in Paris, France. Barus (1966) reported this species from roseate spoonbills from Cuba. The present report represents the first record of *S. diacantha* in the United States. One small nestling collected at South Park Key was infected with what appears to be a new species of *Synhimantus.* The same acuariid has been found in a laughing gull (*Larus atricilla*) from Cedar Key, Florida (Kinsella, unpubl. data).

A single species of the family Tetrameridae was found: *Tetrameres micropenis* (Travassos, 1915). This nematode was identified from 3 nest-

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Table 2. Prevalence and mean intensity of helminths of nestlings, juveniles, and adults of roseate spoonbills from Florida.

Helminth	Nestlings (N = 128) Prevalence %	Nestlings Mean intensity	Juveniles and adults (N = 7) Prevalence %	Juveniles and adults Mean intensity
Trematoda				
A. chandleri	45	332	43	1,444
E. dietzevi	45	545	43	129
P. longa	36	2,068	57	595
M. turgidus	32	114	43	87
A. mcintoshi	30	86	14	1
R. ralli	13	22	0	—
C. complanatum	11	2	14	1
S. denticulata	11	54	0	—
P. minimum	9	36	14	5
P. pindoramensis	8	104	0	—
A. multiovata	4	6	0	—
M. anterovarium	3	46	0	—
D. pulverulenta	0	—	14	1
M. facetum	0	—	14	1
Levinseniella sp.	0	—	14	6
Nematoda				
C. multipapillatum	64	13	43	23
C. obvelatus	39	8	71	10
C. mergi	5	3	71	9
S. diacantha	5	2	29	3
T. micropenis	2	2	0	—
Eustrongylides sp.	<1	1	0	—
Synhimantus sp.	<1	107	0	—
Cestoda				
C. capito	42	33	57	115
P. ibisae	16	12	29	169
Microsomacanthus sp.	0	—	14	25
Acanthocephala				
S. hispida	21	5	57	53
Arhythmorhynchus sp.	<1	1	0	—
Leptorhynchoides sp.	<1	1	0	—

lings, and only males were collected from the proventriculus of each bird.

The family Trichuridae was represented by a single species, *Capillaria mergi* (Madsen, 1945). Specimens of *Capillaria* similar to *C. mergi* have been reported from the brown pelican and the white ibis in Florida (Courtney and Forrester, 1974; Bush and Forrester, 1976).

One immature specimen of *Eustrongylides* sp. (family Dioctophymidae) was found in a nestling collected on Porjoe Key. This specimen probably belongs to the species *E. ignotus* (Jägersk, 1909), since it has been described from other species of wading birds in southern Florida (Spalding et al., 1993).

Cestoda

Cyclophyllidean cestodes were found in 63 (46%) of the birds examined. Two species belonging to the family Dilepididae were identified: *Cyclustera capito* (Rudolphi, 1819) and *Parvitaenia ibisae* (Schmidt and Bush, 1972). *Cyclustera capito* was the most abundant cestode occurring during this study. This species was originally described from a roseate spoonbill from Brazil (Yamaguti, 1959), and more recently it has been reported from the same host in Mexico and Texas (Coil, 1955; Huey and Dronen, 1981). Mature specimens of *P. ibisae* were found frequently in birds of all ages, and unhatched cysticercoids of this cestode were found in the stomachs of 3 nestlings. In Florida, immature specimens have been reported from brown pelicans (Courtney and Forrester, 1974) and black skimmers (Kinsella, 1972), while mature cestodes have been collected only from white ibises (Schmidt and Bush, 1972).

A single species belonging to the family Hymenolepididae was found. *Microsomacanthus* sp. was found in a single adult bird collected on Lake Okeechobee. The specimen had 10 hooks that were 25 μm long and may be the same species reported by Bush (1973) in white ibises from Florida.

Acanthocephala

A total of 35 birds (26%) was infected with acanthocephalans belonging to the order Echinorhynchidea. The family Polymorphidae was represented by *Southwellina hispida* (Van Cleave, 1925) and *Arhythmorhynchus* sp. *Southwellina hispida*, the most abundant acanthocephalan encountered during this study, has been reported from Florida brown pelicans (Courtney and Forrester, 1974). One nestling collected in Tern Key was infected with an immature specimen of *Arhythmorhynchus* sp. Unfortunately, it could not be identified further since the proboscis was retracted.

A single immature specimen of an unidentified species of *Leptorhynchoides* (family Echinorhynchidae) was found in the proventriculus of a nestling collected in Porjoe Key. The specimen closely resembles *L. thecatus* (Linton, 1891), a common parasite of fishes in southern Florida (Bangham, 1940), but differs in having 3 more longitudinal rows of longer hooks. This parasite is probably accidental in roseate spoonbills.

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Table 3. Significant differences of prevalence and mean intensity of helminth infections, by year.

Helminth	Prevalence % 1987–1988 ($N = 38$)	1988–1989 ($N = 33$)	1989–1990 ($N = 31$)	1991–1992 ($N = 25$)	P*	Intensity 1987–1988 ($N = 38$)	1988–1989 ($N = 33$)	1989–1990 ($N = 31$)	1991–1992 ($N = 25$)	P*
Trematoda										
A. chandleri	32	52	61	40	NS†	237	82	832	269	0.03
P. longa	16	42	55	44	0.002	383	4,614	167	2,018	0.03
M. turgidus	18	52	29	44	0.006	74	218	23	49	NS
A. mcintoshi	13	39	48	20	0.04	12	109	105	23	NS
Nematoda										
C. multipapillatum	50	27	26	48	0.04‡	22	5	9	16	0.0009

* P = level of significance for comparisons of prevalence (χ^2) and mean intensity (Wilcoxon test).
† NS = not significant ($P > 0.05$).
‡ Significant differences were found for adult parasites only.

Effect of host sex on helminth infections

The mean intensity of *Echinochasmus dietzevi* infection was significantly higher in nestling females ($\bar{x} = 548$) than nestling males ($\bar{x} = 245$) ($P = 0.04$). Factors responsible for this difference are difficult to explain, particularly because these birds were being fed by their parents. Thul et al. (1985) described a similar phenomenon in immature Florida wood ducks (*Aix sponsa*) infected with the trematode *Prosthogonimus ovatus* and attributed it to anatomical or immunological differences between sexes.

Effect of host body fat on helminth infections

The prevalence of *Cosmocephalus obvelatus* larvae was significantly greater in nestlings with no fat than in nestlings with abundant fat (55 vs. 28%, $\chi^2 = 7.58$, $P = 0.006$). This suggests that *C. obvelatus* infection may lead to poor nutritional condition, or that birds in poor nutritional condition are more susceptible to infection by this particular species.

Effect of year on helminth infections

Prevalence and intensity analyses by year are summarized in Table 3. In general, the prevalences of the trematodes *P. longa, M. turgidus,* and *A. mcintoshi* followed a similar trend over the years, with significant differences explained mainly by the small number of birds infected during 1987–1988 and the high prevalences in 1988–1989 to 1989–1990. *Ascocotyle chandleri,* the most prevalent trematode found during this study, followed the same trend; however, the differences were not significant.

In contrast, the prevalence of the nematode *C. multipapillatum* followed an opposite trend and in 1987–1988, 50% of the birds examined were found infected. During the 1991–1992 breeding season, a similar high prevalence of infection (48%) was observed. In addition, significantly higher intensities of infection with this nematode were reported during those years. Prevalence and intensity of infection with this nematode were significantly lower during 1988–1989 and 1989–1990.

Data available on the life cycles of these helminths indicate that, in general, immature stages of *P. longa, M. turgidus,* and *A. mcintoshi* develop in salt or brackish water intermediate hosts, while larval stages of *C. multipapillatum* are found in freshwater copepods and fishes. Hutton and Sogandares-Bernal (1959) found no metacercariae of *P. longa* in mullet (*Mugil cephalus*) from a freshwater lake in Florida. However, they did find the metacercariae in mullet (*M. cephalus, M. curema,* and *M. trichodon*) from brackish waters in southern Florida and believed that the first intermediate host for this trematode was a salt or brackish water mollusk. Leigh (1956) found mosquitofish (*Gambusia affinis*) from the Everglades infected with metacercariae of *A. mcintoshi* and speculated that the cercariae occurred in small brackish water snails. He later described the prosobranch snail, *Littoridinops monroensis,* as the first intermediate host and added the brackish-water fish *Poecillia latipinna* to the list of second intermediate hosts for this trematode (Leigh, 1974). The microphallid *M. turgidus* utilizes the snails *L. monroensis* and *L. tenuipes* as first intermediate hosts in southern Florida, and

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shrimp of the genus *Palaemonetes* sp. as second intermediate hosts (Heard and Overstreet, 1983). Even though *G. affinis* and *Palaemonetes* sp. are found commonly in freshwater habitats, Bush and Forrester (1976) found no specimens of *A. mcintoshi* and *M. turgidus* in white ibises from freshwater areas in Florida.

Larval stages of *C. multipapillatum* have been found in freshwater fishes in Florida (*Micropterus salmoides, G. affinis, Lepomis* sp.) and experimentally this nematode has been found to be highly infective to freshwater copepods (Huizinga, 1965).

The lower prevalences of trematodes observed during 1987–1988 are likely to be a reflection of a decrease in the availability of infected brackish water intermediate hosts. On the other hand, the high prevalence and intensity by *C. multipapillatum* in 1987–1988 and 1991–1992 can be attributable to an increase in the presence of infected freshwater copepods and fishes. Even though other factors probably contributed to the observed differences in prevalence and intensity of infection, it is possible that they were the result of hydropattern changes on the roseate spoonbills' feeding grounds through the years. In fact, during the dry seasons of 1988–1989 and 1989–1990, the drying out of brackish water wetlands concentrated fishes and invertebrates and thus made them more available as prey for roseate spoonbills (Bjork and Powell, 1993). In contrast, during 1987–1988 and 1991–1992, the surrounding wetlands were flooded by rainfall and/or canal discharges (Bjork and Powell, 1993). The effect of the decrease in salinity during the wet years on populations of marine and brackish water fishes is unknown. However, during those years, eggs of *C. multipapillatum*, which are thin-shelled and nonresistant to drying (Huizinga, 1965), probably found excellent conditions for their development.

The absence of a major decrease in the prevalence of trematodes during 1991–1992 is difficult to understand. However, the significant differences in prevalence and intensity of *C. multipapillatum* between wet and dry years might mean that this nematode is more susceptible to drought conditions than the trematodes.

Of particular interest were the differences in intensities of *A. chandleri* and *P. longa* infections between years. Generally, in years of high intensity of *A. chandleri* there was a low intensity of *P. longa* and vice versa. In addition, for both parasites, years of high intensity of infection were generally followed by years of low intensity of infection.

Effect of locality on helminth infections

Prevalence and intensity analyses by locality are summarized in Table 4. Generally, prevalence and intensity of helminths were greater in roseate spoonbills from the east colonies than in birds from the west colony. *Clinostomum complanatum, C. multipapillatum, C. obvelatus,* and *S. hispida* were found in significantly higher prevalences and/or intensities in nestlings from the east colonies, while *S. diacantha* and *P. ibisae* were found in significantly greater prevalences and/or intensities in nestlings collected in the west colony (Table 4).

Differences in roseate spoonbill food habits and/or in prevalence and intensity of infection of intermediate hosts between east and west Florida Bay are some factors that may have caused the differences observed in prevalence and intensity of infection between the 2 areas. Because of the scarce information available on the food habits of roseate spoonbills and on the degree of infection of invertebrates and fishes from the area, few conclusions can be drawn from the present study.

Immature stages of *Parvitaenia* sp. have been reported from *Fundulus confluentus, F. grandis, Cyprinodon variegatus,* and *G. affinis* (Bush, 1973). Lorenz and Powell (1992) found that *G. affinis* was a very common species in west Florida Bay, and that *F. confluentus* and *F. grandis* occurred very rarely in that area. The fact that Powell and Bjork (1990) found a higher percentage of *C. variegatus* in regurgitations of nestlings collected in the eastern colonies indicates that the difference in prevalence of *Parvitaenia ibisae* between birds from west and east Florida Bay may be the result of differences in the availability of infected mosquitofish (*G. affinis*) between the 2 areas.

Effect of host age on helminth infections

Prevalence and intensity analyses by age of the host are summarized in Table 4. In general, prevalence and intensity of helminths were greater in larger nestlings than in smaller nestlings. *Ascocotyle chandleri, R. ralli, C. obvelatus, C. mergi,* and *C. capito* were found in significantly greater prevalences and/or intensities in larger nestlings, while *E. dietzevi* was the only helminth that showed a significantly higher intensity of infection in smaller nestlings (Table 4).

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Table 4. Significant differences of prevalence and mean intensity of helminth infections, by locality and age.

	Prevalence %						Intensity					
	Locality			Age*			Locality			Age		
Helminth	West (34)	East (99)	P†	I (105)	II (23)	P	West (34)	East (99)	P	I (105)	II (23)	P
Trematoda												
A. chandleri	50	44	NS	45	48	NS	108	492	NS	136	1,152	0.02
E. dietzevi	47	46	NS	46	48	NS	643	474	NS	648	88	0.002
R. ralli	12	12	NS	10	26	0.02	49	13	NS	27	14	NS
C. complanatum	0	15	0.01	13	4	NS	—	2	NS	1	3	NS
Nematoda												
C. multipapillatum	24	45	0.01‡	67	61	NS	6	15	0.002	14	9	NS
C. obvelatus	53	35	NS	10	35	0.007‡	5	10	0.03	7	11	0.04
C. mergi	3	9	NS	1	26	0.0002	2	3	NS	1	3	NS
S. diacantha	15	2	0.02	3	13	NS	1	2	NS	2	2	NS
Cestoda												
C. capito	53	41	NS	42	48	NS	4	36	NS	29	51	0.03
P. ibisae	32	11	0.02	18	13	NS	20	6	0.01	14	3	NS
Acanthocephala												
S. hispida	12	28	0.02	23	17	NS	3	13	NS	5	6	NS

* I = small nestlings; II = large nestlings.
† *P* = level of significance.
‡ Significant differences were found for adult parasites only.

The higher prevalences and intensities of helminths observed in older nestlings can be attributed to the fact that these birds had a greater opportunity for successive infections than younger ones, and that the time required for helminths to mature had probably occurred in the majority of the older birds. Additionally, this difference could be a reflection of changes in the availability of infected prey for parent birds and/or changes in the intensity of infection of these food items as the breeding season progresses.

The present study points out some discrepancies regarding the effect of age on the intensities of infection of members of the genus *Ascocotyle.* Sogandares-Bernal and Bridgman (1960) and Sogandares-Bernal and Lumsden (1964) found that nestling ardeids (1–4 days old) had higher intensities of infection with *Ascocotyle* spp. than their parents and attributed this decrease to an age immunity factor. Due to the fact that only nestling roseate spoonbills were included in the *A. chandleri* intensity statistical analysis, a decrease in intensity as birds grow older cannot be disproven. However, juveniles and adults were found harboring apparent higher numbers of this parasite than nestlings (Table 2).

The increase in prevalence and intensity of *C. obvelatus* with age has been reported previously in ring-billed gulls (*Larus delawarensis*) from Lake Ontario, Canada (Wong and Anderson, 1982). Examining young-of-the-year, those authors found a general increase in prevalence (reaching 100% in 2 wk) and in intensity (increased for approximately 28 days and then again at 35–42 days of age) as birds grew older.

The decline in intensity of *E. dietzevi* in large nestlings may be attributable to changes in intermediate host availability during the nesting season, development of immunity, physiological and anatomical changes associated with age, and/or competition with other helminths inhabiting the small intestine.

The significance of helminth infections to roseate spoonbills

The occurrence of a relatively high prevalence and/or high intensity of *P. longa, A. chandleri, E. dietzevi, C. multipapillatum, R. ralli,* and *S. hispida* leads us to believe that these helminths might act as potential pathogens to roseate spoonbills. Heterophyids, members of the genus *Renicola,* and *C. multipapillatum* have been implicated in severe pathological changes and even death of avian hosts (Sogandares-Bernal and Lumsden, 1964; Huizinga, 1965; Riley and Owen, 1972).

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The similarity between the helminthofaunas of roseate spoonbills and white ibises in Florida, both members of the family Threskiornithidae, was high (index of similarity for all helminths was 41%). This is a strong indication of the similarity of food habits and habitat use by both species. In contrast, roseate spoonbills in Florida appear to share only a few helminth species with Texas roseate spoonbills (Huey and Dronen, 1981; Dronen, 1985), which may mean that there are differences in diets between populations. However, because only 2 Texas spoonbills have been examined and the age of these birds was not reported, further work is needed for a better understanding of these differences.

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